Space Weather Technical Forecast

Issued on Tuesday 4 February 2025 at 00:33 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Solar winds easing. Chance of a glancing blow from a CME Day 3 (06 Feb). Further M-class flares expected, slight chance of an X-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was moderate over the past 24 hours, with frequent M-class flares, most of which originated from AR3981. The strongest recorded was an M8.8 flare, peaking at 03/0358 UTC.

There are now ten active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots which are beginning to cross the central disc from the northeast quadrant into the western hemisphere, and consist of AR3976, AR3977, AR3978, AR3981 and AR3982. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976, AR3977 and AR3978 continue to slowly evolve but have shown some very slight recent overall decay. AR3981 meanwhile continues to increase in overall areal extent, and has two delta configurations within its intermediate and trailer spots. This region continues to produce the majority of the flare activity, including the largest M-class flare of the period. AR3982 located to the north of AR3978, has shown steady decay in recent hours. The remaining spots, including the four unnumbered NEW groups, are small and currently magnetically simple.

An M4.1 flare from AR3981 at 02/2324 UTC was followed by a faint CME from the southeast in imagery. This has been analysed to potentially give a glancing blow at Earth on 06/0700UTC, although this is low confidence.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE at L1 showed a declining connection to CH11/+, with speeds initially near 550 km/s falling to around 450 km/s. Density was average to below average. The Interplanetary Magnetic Field, Bt, was initially moderate, peaking at around 12nT, but steadily decreased to current weak levels. The north-south component, Bz, was weakly positive throughout. Phi angle was mainly positive (away from the Sun). Geomagnetic activity Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels, peaking at 217 pfu. The associated 24-hour fluence persisted below the Active threshold, recording 6.37e6 integrated pfu at 04/0000UTC.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Moderate activity is expected, with M-class flares expected at times and a slight chance of isolated X-class flares, primarily from the regions in the north now approaching centre disc.

Solar Wind / Geomagnetic Activity: A CME associated with an M4.1 flare late on 02 Feb may give a glancing blow with Earth on the morning of Day 3 (06 Feb), although this is low confidence. The potential for further CMEs is elevated.

Earth is still connected to CH11/+, but with wind speeds continuing to decline, likely returning to background levels by Day 2 (05 Feb). Solar winds may return to slightly elevated or elevated levels for a time on Day 3 (06 Feb), following any potential CME arrival.

Generally Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected as Earth continues to come out of the coronal hole high speed stream. Following any potential CME arrival on Day 3, there is a chance of seeing activity temporarily increase to give active or G1/Minor Storms (Kp4-5).

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is likely to be at background levels, but with a slightly increasing potential of responding to any notable flares as the sunspot regions in the north move into the western hemisphere. GOES16 high energy electron flux is likely to remain at Moderate to High levels through the period. The corresponding 24 hour fluence is expected to persist below the Active threshold (04 Feb), but with an expected rising trend Days 2-3 (05-06 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period, in the absence of further CME activity.

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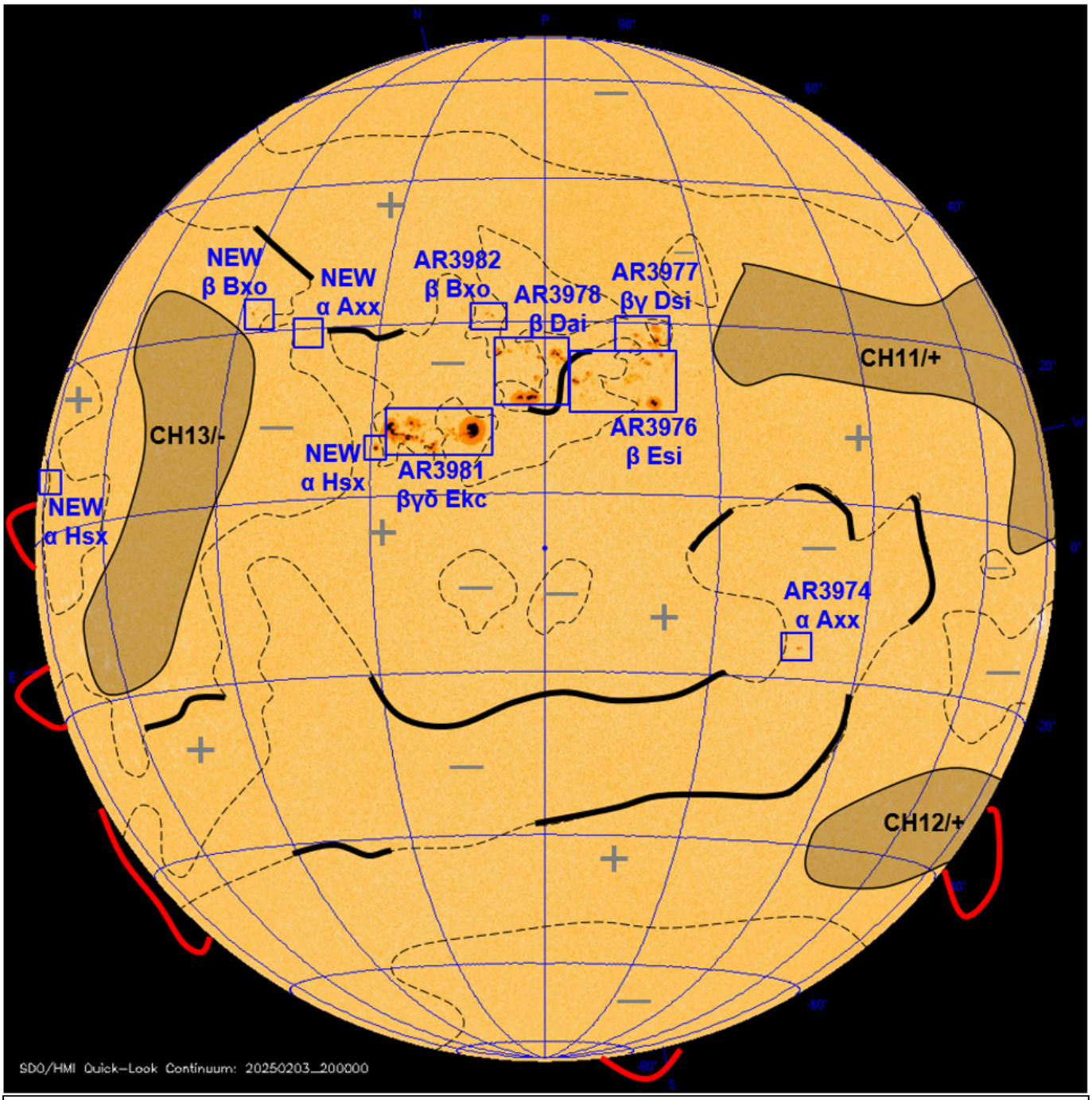
Figure 1: Solar Synoptic Map valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

One CME currently features in the forecast, a faint CME associated with an M4.1 flare at 02/2320 UTC from AR3981. This CME was faint and occurred at a similar time as a larger, far-sided CME, which lowers the confidence of analysis. However there is a possibility the CME could make a glancing impact with Earth on the morning of Day 3 (06 Feb). The potential for further CMEs also remains elevated, with a number of large filaments in potentially geoeffective positions and the large cluster of the sunspots to the north currently rotating through centre-disc.

Earth is still connected to CH11/+ but with wind speeds continuing to be decline, currently around 450km/s. Solar wind speeds are expected to gradually ease during Day 1 (04 Feb), likely returning to generally background levels by Day 2 (05 Feb). MOSWOC ENLILs gradual decline is accepted, although it currently overestimates solar wind speeds. Solar winds may return to slightly elevated or elevated levels for a time on Day 3 (06 Feb), following any potential CME arrival.

Generally Quiet to Unsettled (Kp 1-3) geomagnetic activity is expected as Earth continues to come out of the coronal hole high speed stream. Following any potential CME arrival on Day 3, there is a chance of seeing activity temporarily increase to give active or G1/Minor Storms (Kp4-5).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	30	10
Strong	G3	No	1	1	3	1
Severe	G4	No	1	1	1	0
Extreme	G5	No	1	1	1	0

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
03/0457	Partial	AR3981	NE	590	06/0700 +/- 6 hours	Chance of glancing impact, but low confidence.

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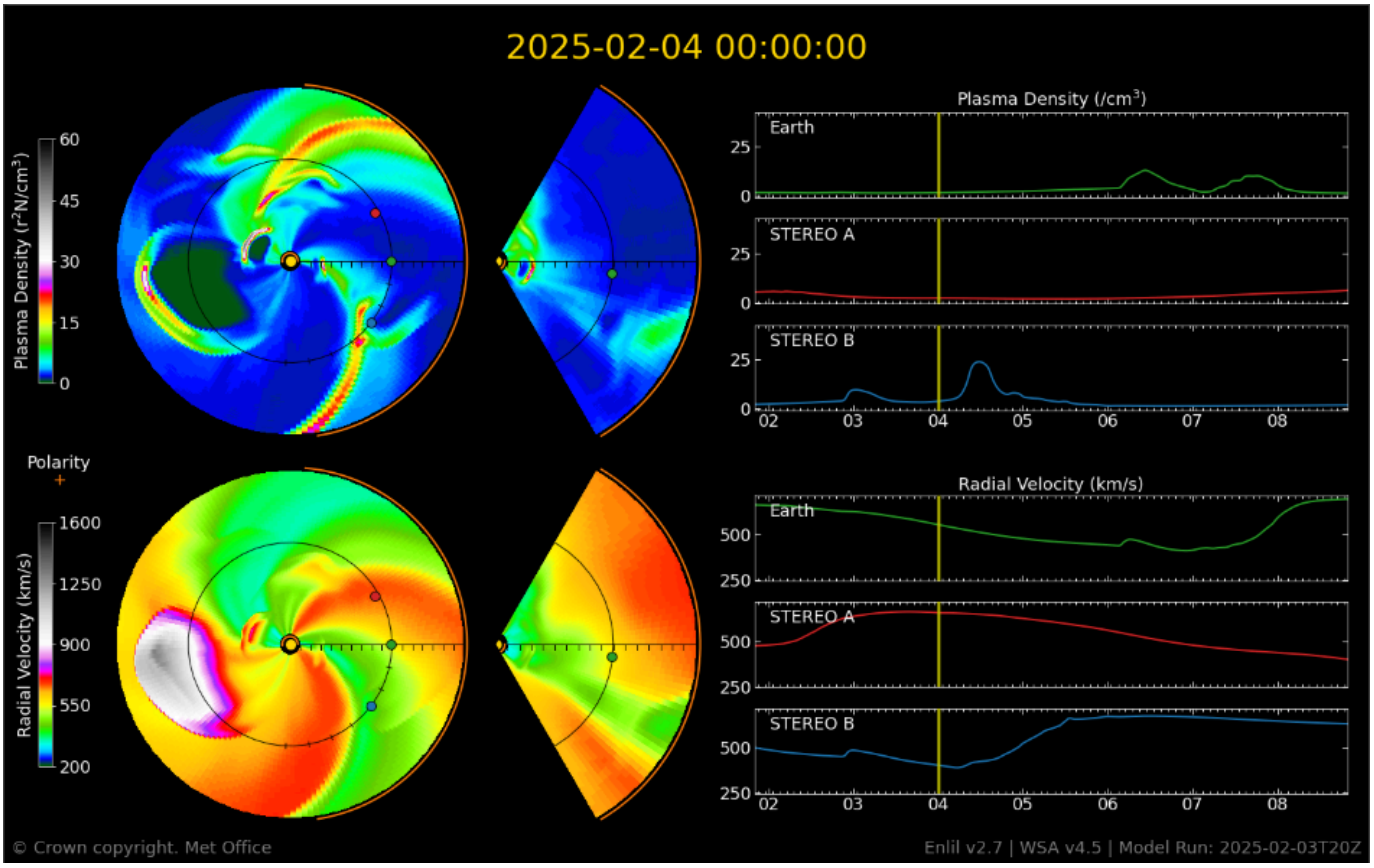
Figure 2: MOSWOC Enlil, showing the general declining trend in fast winds.



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Radio Blackouts - X-Ray Flares

Solar activity was Moderate over the last 24 hours with frequent M-class flares, the largest an M8.8 peaking at 03/0358UTC from AR3981.

There are now up to eight active regions on the Earth-facing disc. The majority of the activity is from the broad cluster of sunspots which are beginning to cross the central disc from the northeast quadrant, and consist of AR3976, AR3977, AR3978, AR3981 and AR3982. These form a rather large and complex area of multiple bipolar active regions, with signs of magnetic interaction between the regions suggesting the ongoing potential for notable flares. AR3976 and AR3978 continue to slowly evolve but remain Beta-Gamma magnetic types. AR3977 has recently seen some further small spots emerge in the lead portion, and gave an M5.1 flare on 02 Feb. AR3981 continues to exhibit sustained growth, especially in the intermediate and trailer portions, with at least two delta configurations evident. This region has produced the majority of the Moderate flares through the period, including the largest, an M8.8 on 03 Feb. AR3982 located to the north of AR3978, has shown steady decay in recent hours. The remaining spots groups are small and magnetically simple, with either limited evolution or slow decay.

No significant regions are due to rotate off the disc in the forecast period. Recurrence suggests the potential for returning regions during the period, although far-side helioseismic output has no strong signals in the short term. Overall further M-class flares are expected, with the risk maintained throughout the period pending further developments. There is a slight chance of an isolated X-class flare from the cluster in the northeast given its overall size and complexity.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	20	20	20	20

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Figure 3: GOES-16 & -18 X-ray flux showing multiple M-flares, all from the cluster of sun regions in the northeast of the disc, and the majority from AR3981.

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Solar Radiation Storms (High Energy Protons)

Proton flux as observed by GOES-18 is currently at background levels, and is generally likely to remain that way, at least at first. As the large cluster of sunspots in the north move from centre-disc into the western hemisphere, there is a gradually increasing chance of proton flux rising in response to any notable flares.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	25	30
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 saw a diurnal peak to High levels on 02 Feb as the fast winds from CH11/+ slowly subsided. This suggests that the Van Allen belts are beginning to expand outward again after a period of compression and lower-orbit charging. However, flux levels remained at Moderate levels on 3 Feb. As solar wind speeds are expected to ease further through Days 1 (04 Feb), the Van Allen belts should continue to expand back towards GEO, bringing an increase in flux. Electron flux could continue to be at Moderate to High levels through the period. However, the potential for a glancing blow from a CME early on Day 3 (6 Feb) adds uncertainty, as it could temporarily suppress the Van Allen belts back to lower orbits.

The corresponding 24 hour fluence is expected to persist below the Active threshold (04 Feb), but with an expected rising trend Days 2-3 (05-06 Feb), bringing an increasing chance of reaching the Active threshold by the end of the period, in the absence of further CME activity. MOSWOC REFM output is currently thought to be providing reasonable guidance, although confidence is reduced due to uncertain CME impacts.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	10	20	30	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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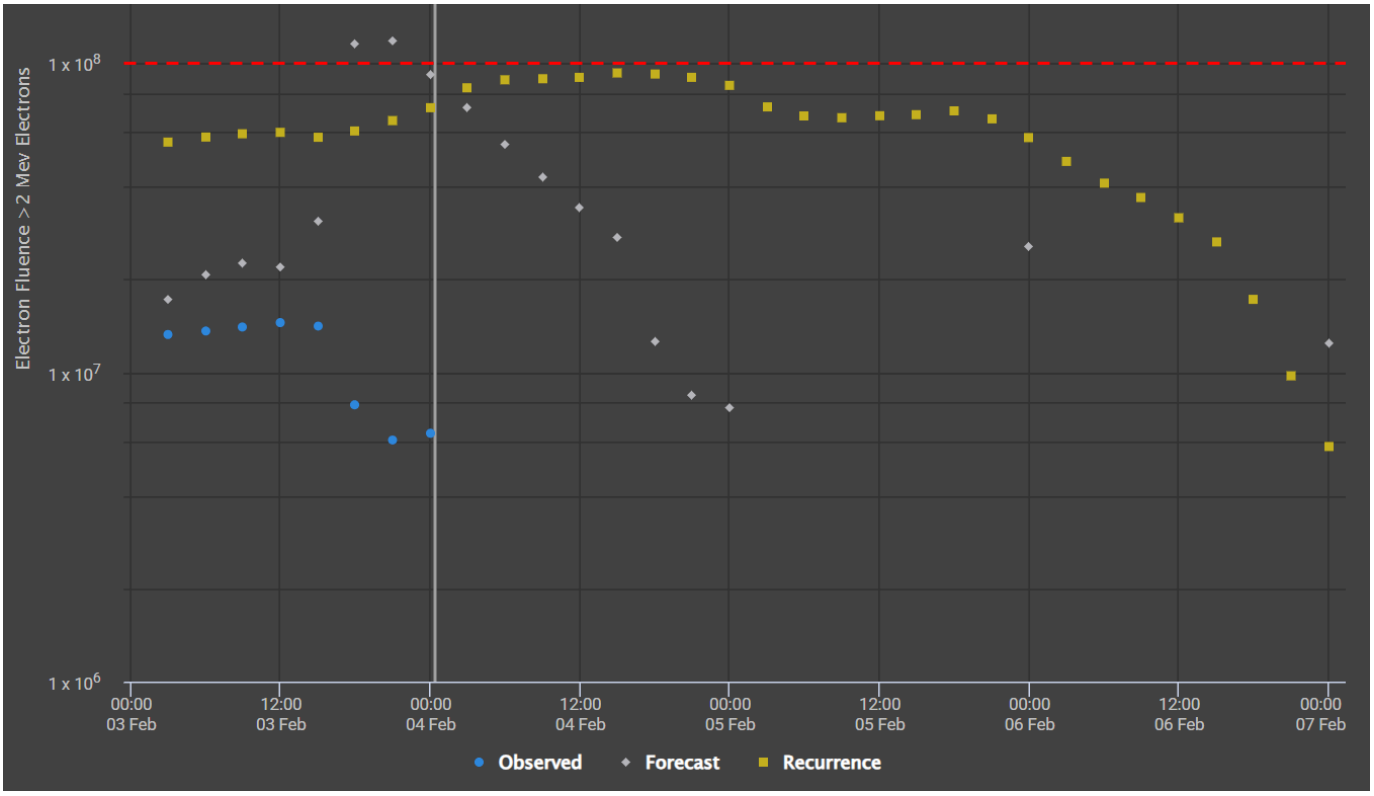
Figure 4: MOSWOC REFM, providing reasonable guidance.



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